

VT response to reviewer comments on LRR Final Report

February 15, 2011

Upon reviewing the comments from the reviewers, several key issues were identified for further clarification. Each issue is discussed in detail in this document. Additionally, changes were made accordingly to the report. The changes and their locations are noted here. While this document focuses on comments that were shared by more than one reviewer, the minor comments have also been addressed in the report text. It should be noted that in this document, the terms “study reach” and “study sites” refer to those described in the report. The authors would like to thank the reviewers for their thoughtful comments and insight. These comments have helped strengthen the report and clarify the important conclusions.

1. Location of the study reach

Recent studies (Hupp et al. 2009, Schenk et al. 2010) have found that the more active sites in terms of bank retreat are located downstream of the study reach. Understandably, reviewers commented that it would have been useful to collect data and perform simulations in this downstream region. Unfortunately no work was performed in this region, in part, due to a lack of knowledge of the distribution of bank retreat at the time the study sites were selected. The primary reasons that the study sites were selected are the following:

- (a) Evidence of bank retreat was observed throughout the study reach.
- (b) The study sites exhibit a range of geotechnical and hydraulic features.
- (c) Sites were reasonably accessible.
- (d) Peaking affects the stage on the study reach.
- (e) The study reach was far enough upstream that tidal effects were not important.

The collection of field data required to build the appropriate numerical models was intensive and time consuming. Most of this effort was complete at the time the regions of higher bank retreat rates were identified. Given that it would be impossible to reproduce the work at a different location in a timely manner, the decision was made to continue the work at the originally selected sites. This decision ensured that the models would be built with the appropriate data and

provide quality results. Clarification on the reasons for selecting the study sites was added to the introduction of the report (p. 1).

2. Extrapolation of results

Following from the previous item, the question arises whether the findings of the present study can be extrapolated downstream to the areas of more active bank retreat. To quantify fluvial erosion and bank stability at a site requires detailed information on the soil properties, channel bathymetry, bank geometry, and flow characteristics. This information requires a carefully planned field campaign, such as was carried out on the study reach. Additionally, based on the observations of several reviewers, the processes that generate bank retreat at the sites experiencing the highest rates of bank retreat may be significantly different from those on the study reach.

3. Clarification of step-down rate

The groundwater table monitoring data and in situ hydraulic conductivity show that the soil moisture in the riverbank responds quickly to changes in the water surface elevation (WSE). This observation, in terms of slope stability, means that the excess pore pressure that may lead to failure is not likely to be present over the entire riverbank. In addition, the most critical step-down is a rapid drawdown case where the WSE drops almost instantly. The banks were determined to be stable for the case of rapid drawdown. For this reason, large-scale instability of the riverbanks is not sensitive to the drawdown rates that can be generated on the study reach. However, localized regions of soils with lower permeability may exist as found in the laboratory tests. These areas may experience small-scale failures as the WSE decreases, such as those observed at several locations along the study reach. A statement to this effect was added on p. 48 of the report.

4. Floodplain inundation at flow rates below bankfull

Reviewers noted that water may enter the floodplain at flow rates less than the bankfull flow rate of about 20,000 cfs, especially downstream of the Hamilton gaging station. Causes include breaches in the banks and flow from tributaries. Depending on the geometry of a riverbank, this water in the floodplain may result in an additional load applied to the bank and increase the soil

moisture content in the riverbank. To influence the bank stability in terms of an additional loading, the water must be close enough to the bank edge to be captured by the failure envelope. Based on predicted failure envelopes and observed past large-scale failures on the study reach, the additional load would need to be applied within about 10 m from the bank edge. In addition, water in the floodplain may result in fully saturated conditions of the local riverbank. For slope stability calculations, fully saturated soil represents the most critical condition which has been considered in the report. Fully saturated conditions in the riverbank are considered for slope stability calculations in the report. A discussion of these issues was added to the report (p. 37).

5. Variability in field data

Due to the significant amount of time required to carry out field tests for soil erodibility and permeability, a fairly small number of tests were obtained from a statistical standpoint. However, it should be noted that in the case of the jet test, the number of tests exceeds most published studies. To address this limitation, a range of values was considered for both soil permeability and the critical shear stress for erosion. For permeability, this range included values obtained from the groundwater table monitoring, which resulted in higher values, and laboratory tests, resulting in lower values. Most of the measured critical shear stress values were above the applied shear stress for all flow rates. This result indicates that widespread fluvial erosion does not occur on the study reach. However, some test did result in critical shear stress values that would result in erosion, which is support by observations of some localized erosion. For this reason, a worst case scenario was investigated where a lower critical shear stress value was assumed to cover the entire bank. The authors feel that this is the most appropriate method to handle the large variability seen in the field data.

6. Seasonal effects

The data collection was carried at discrete intervals, typically in May and June, meaning that seasonal trends cannot be determined from the field data. While the role of seasonal effects was not explicitly investigated, the range of flows and soil moisture conditions included in the modeling allows for some evaluation of seasonal effects when specific flow and soil moisture conditions are given. However, certain seasonal features that may be important for erosion, such as freeze-thaw, cannot be evaluated.

The groundwater table monitoring data presented in Figure 3.6 was used to estimate the far field boundary condition for the seepage model. The location of the USGS groundwater monitoring station is several kilometers from the study reach and, thus, not representative of soil moisture conditions near the riverbank. Clarification was added to p. 18 of the report.